TITLE OF THE INVENTION

Ink Cartridge And Inkjet Printer

BACKGROUND OF THE INVENTION

The present invention relates to ink cartridges and inkjet printers.

Generally, color inkjet printers use a plurality of color inks. These printers may include a plurality of separate color ink cartridges that are independently replaceable. This structure allows the ink cartridges to be consumed completely, thus reducing costs.

In an inkjet printer that uses the separate ink cartridges, a cartridge accommodating portion accommodates the ink cartridges. Each ink cartridge must be accurately located at a predetermined position of the accommodating portion. Further, since each ink cartridge corresponds to a different color, the cartridges must be aligned in the accommodating portion in a predetermined order.

Conventionally, a positioning member divides the cartridge accommodating portion into a plurality of chambers. The positioning member positions each ink cartridge in the corresponding chamber, thus installing the cartridge in the printer.

However, the positioning member complicates the structure of the cartridge accommodating portion. Further, the cartridge accommodating portion must have a clearance for receiving the positioning member, in addition to the cartridge chambers. This enlarges the cartridge accommodating portion.

In an inkjet printer described in Japanese Unexamined Patent Publication No. 4-185355, an accommodating recess is formed as the cartridge accommodating portion. Convex and concave portions are formed in the inner wall of the recess. Matching convex and concave portions are formed in the outer wall of each ink cartridge. That is, when each cartridge is received in the recess, the convex and concave portions of the cartridge engage with those of the inner wall of the recess. In this manner, the cartridge is positioned in the recess.

However, in this case, the convex and concave portions must be formed with a high accuracy such that each ink cartridge is positioned in the recess accurately and reliably. The forming of the convex and concave portions is thus complicated. Particularly, machining of the inner wall of the recess is complicated such that production efficiency decreases.

In an inkjet printer described in Japanese Unexamined Patent Publication No. 61-41553, a plurality of head units are attached to a reciprocating carrier. Each head unit accommodates an ink container and includes an engaging projection and an engaging recess through which the head unit is connected to the adjacent head unit.

In this printer, each head unit accommodates a different color ink, and the head units must be aligned in a predetermined order. However, since these head units are identical, it is highly likely that the head units are aligned in an inaccurate order.

BRIEF SUMMARY OF THE INVENTION

Accordingly, it is an objective of the present invention to provide an ink cartridge that is easily and accurately installed in a cartridge accommodating portion of an inkjet printer and has a simple structure to minimize the cartridge accommodating portion.

It is another objective of the present invention to provide an inkjet printer that includes the ink cartridge.

To achieve the foregoing and other objectives and in accordance with the purpose of the present invention, the invention provides an ink cartridge for an inkjet printer. The ink cartridge is one of ink cartridges that are detachably attached to a cartridge accommodating portion of the inkjet printer as aligned in parallel. Each ink cartridge has at least one engaging portion formed at a side of the ink cartridge that faces an adjacent ink cartridge. A set of the opposed engaging portions of each pair of adjacent ink cartridges forms a matching set in which the engaging portions engage with each other to position the adjacent ink cartridges with respect to each other. The matching sets are shaped and located such that a fitting structure between one pair of adjacent ink cartridges and a fitting structure between another pair of adjacent ink cartridges are different in form.

In another aspect of the present invention, each ink cartridge includes a contact that contacts one of connecting members formed in the cartridge accommodating portion when the ink cartridge is attached to the cartridge accommodating portion. Each contact is located offset from the middle of the associated ink cartridge in an aligning direction of the ink cartridges.

Other aspects and advantages of the invention will become

apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a schematic view showing an inkjet printer of a first embodiment according to the present invention;

Fig. 2 is a block diagram showing the circuit configuration of the inkjet printer of Fig. 1;

Fig. 3 is a perspective view showing a carriage of the printer of Fig. 1 in which ink cartridges are installed;

Fig. 4 is an exploded, perspective showing the carriage of Fig. 3;

Fig. 5 is a perspective view showing a cartridge holder of Fig. 4;

Fig. 6 is a perspective view showing an ink cartridge;

Fig. 7 is a perspective view showing combined ink cartridges;

Fig. 8 is a cross-sectional view showing the ink cartridge and the carriage:

Fig. 9 is a plan view showing the ink cartridge and a cartridge holder;

Fig. 10 is a plan view showing an ink cartridge and a cartridge holder of a second embodiment according to the present invention;

Fig. 11 is a plan view showing an ink cartridge and a cartridge holder of a third embodiment according to the present invention;

Fig. 12 is a plan view showing an ink cartridge and a

cartridge holder of a fourth embodiment according to the present invention; and

Fig. 13 is a plan view showing an ink cartridge and a cartridge holder of a fifth embodiment according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(First Embodiment)

A first embodiment of the present invention will now be described with reference to Figs. 1 to 9. Fig. 1 shows the general structure of an inkjet printer 21. As shown in the drawing, the printer 21 includes a paper conveying mechanism that moves a sheet of paper 22 and a moving mechanism that moves a carriage 30, or an ink cartridge accommodating portion. The carriage 30 includes a printing mechanism that discharges ink on the sheet of paper 22 for printing.

The paper conveying mechanism includes a paper conveying motor 23, a paper conveying roller 24, and an additional roller (not shown). The paper conveying motor 23 functions as a drive source. The paper conveying roller 24 also functions as a platen roller. When the paper conveying motor 23 is activated, the paper conveying roller 24 and the additional roller are rotated to convey the sheet of paper 22.

The moving mechanism includes a guide member 35, a carriage motor 36, a pair of pulleys 38, and a timing belt 37. The guide member 35 is parallel with the axis of the paper conveying roller 24. The carriage motor 36 functions as a drive source. The timing belt 37 connects the pulleys 38 to each other. One pulley 38 is connected to the carriage motor 36. The carriage 30 is connected to the timing belt 37. When

the carriage motor 36 is activated, the carriage 30 reciprocates along the guide member 35. More specifically, the carriage 30 moves in an axial direction of the guide member 35, or in a direction perpendicular to a conveying direction of the sheet of paper 22.

As shown in Fig. 2, the inkjet printer 21 includes a controller 28, a read only memory (ROM) 28a, and a random access memory (RAM) 28b. The controller 28 is, for example, a central processing unit (CPU). The ROM 28a stores various programs and the RAM 28b stores working data. The controller 28 controls the paper conveying mechanism, the moving mechanism, and the printing mechanism, thus performing color printing on the sheet of paper 22.

As shown in Figs. 3 to 5, the carriage 30 includes a carriage body 31 and a cartridge holder 41. The cartridge holder 41 is secured to the carriage body 31 through, for example, a screw (not shown).

The cartridge body 31 has a side wall 31a and a bottom 31b. A sleeve 32 and a connector 33 are located at the outer side of the side wall 31a. The sleeve 32 has a through hole through which the guide member 35 is passed. The connector 33 is connected to the timing belt 37.

The cartridge holder 41 includes a side wall 41a and a square bottom 41b. A vertical rib 42 projects from each corner of the bottom 41b. Each rib 42 has an L-shaped cross-section. The side wall 41a connects two ribs 42 to each other. A plurality of (in this embodiment, seven) ink cartridges 61 are placed on the bottom 41b as held by the ribs 42.

The side wall 41a has a plurality of (in this embodiment, four) windows 45. Each window 45 has an open, upper end. A connecting member 47 is fitted in each window 45. More specifically, a groove 45a is formed in the sides of each window 45, and each connecting member 47 includes a projection that is fitted in the groove 45a. A pair of contact groups 47a are formed at opposite sides of each connecting member 47. That is, one contact group 47a projects from the front side of each connecting member 47, and the other projects from the rear side of the connecting member 47. The contact groups 47a that project from the opposite sides of each connecting member 47 are connected to each other in the connecting member 47.

A printing head 51 functions as the aforementioned printing mechanism and is located in the cartridge holder 41. The printing head 51 includes a base 53, a head unit 52, and an IC board 54. The base 53 has a substantially L-shaped cross section. The head unit 52 discharges an ink drip. The IC board 54 controls the head unit 52. The base 53 includes a side wall 53a and a bottom 53b. The side wall 53a of the base 53 opposes the side wall 41a of the cartridge holder 41. The bottom 53b of the base 53 is secured to the lower side of the bottom 41b of the cartridge holder 41. A plurality of windows 55 are formed in the side wall 53a to oppose the corresponding windows 45 of the cartridge holder 41. Each connecting member 47 is thus fitted in the corresponding windows 45, 55.

The head unit 52 is secured to the bottom 53b of the base 53. The head unit 52 includes an inkjet mechanism 52a (see Fig. 8) and a plurality of (in this embodiment, seven) ink supply needles 56. The inkjet mechanism 52a discharges an ink drip. When the ink cartridges 61 are installed in the cartridge holder 41, each ink supply needle 56 supplies ink from the corresponding ink cartridge 61 to the inkjet

mechanism 52a. That is, one ink supply needle 56 corresponds to one ink cartridge 61 that is installed in the cartridge holder 41. Each ink supply needle 56 extends from the bottom 53b of the base 53 and passes through the bottom 41b of the cartridge holder 41, thus projecting upward vertically.

The IC board 54 is attached to the side wall 53a of the base 53 and is connected to the contact group 47a that projects from the front side of each connecting member 47. Further, a flexible flat cable 27 (see Fig. 1) is connected to one end of the IC board 54. The flexible flat cable 27 connects the IC board 54 to the controller 28.

Each ink cartridge 61 is detachably attached to the cartridge holder 41. The ink cartridges 61 are substantially identical. The structure of each ink cartridge 61 will hereafter be described.

As shown in Figs. 6 to 8, each ink cartridge 61 is shaped as a substantial rectangular parallelepiped. As shown in Fig. 7, the seven ink cartridges 61 are attached to the cartridge holder 41 such that the adjacent ink cartridges 61 closely contact each other. Each of the two ink cartridges 61 that correspond to opposite ends of the cartridge holder 41 has a single engaging portion 62 that is formed at one side of the ink cartridge 61. Each of these ink cartridges 61 engages with the adjacent ink cartridge 61 through the engaging portion 62. Each of the remaining five ink cartridges 61 has a pair of engaging portions 62 that are formed at opposite sides of the ink cartridge 61. Each of these five ink cartridges 61 engages with the adjacent ink cartridges 61 through the engaging portions 62.

The ink cartridge 61 that corresponds to one end of the

cartridge holder 41 (located rightmost as viewed in Fig. 7) has a projection 62a that functions as the engaging portion 62. The ink cartridge 61 that corresponds to the other end of the cartridge holder 41 (located leftmost as viewed in Fig. 7) has a recess 62b that functions as the engaging portion 62. The remaining five ink cartridges 61 each include the projection 62a and the recess 62b.

Each projection 62a projects in a direction in which each ink cartridge 61 is moved for attaching the ink cartridge 61 to the cartridge holder 41 (as indicated by the axis Y of Fig. 3). The shape of the recesses 62b matches that of the projections 62a. When the ink cartridges 61 are attached to the cartridge holder 41, the adjacent ink cartridges 61 are connected to each other through engagement between each projection 62a and the matching recess 62b.

Each ink cartridge 61 has a front side 61a a lower portion of which forms a recess. A plurality of parallel ribs 60 are received in the recess. A circuit board 63 is attached to the corresponding ribs 60 of each ink cartridge 61. Each circuit board 63 is located near to one lateral side (the right side or the left side) of the ink cartridge 61.

Although not illustrated, each circuit board 63 includes a non-volatile memory (EEPROM). The EEPROM is rewritable and retains its content even when power supply is blocked. Each EEPROM stores data such as the ink content, the date of production, and the production number of the corresponding ink cartridge 61. A contact group (not shown) is formed on the front side of each circuit board 63, and the EEPROM is located on the rear side of the circuit board 63. An ink-resistant material encompasses each circuit board 63 except for the contact group. As shown in Figs. 8 and 9, when each ink

cartridge 61 is attached to the cartridge holder 41, the contact group of the circuit board 63 contacts the contact group 47a that projects from the rear side of the corresponding connecting member 47.

As shown in Fig. 8, each ink cartridge 61 includes a synthetic resin container 64, a porous body 65, and a lid 66. The container 64 is shaped as a substantial rectangular parallelepiped and has an upper opening. The porous body 65 is accommodated in the container 64. The lid 66 closes the opening of the container 64 and is joined with the container 64 through, for example, vibration depositing.

A projection 70 projects from the bottom of the container 64 of each ink cartridge 61 near the front side 61a of the ink cartridge 61. An ink supply port 69 is formed in each projection 70 for supplying ink from the associated container 64 to the inkjet printer 21. A valve mechanism 72 is located in each ink supply port 69. A rubber seal (not shown) is fitted in each ink supply port 69.

Each porous body 65 is formed of elastic material that has a number of continuous pores. The porous body 65 absorbs the ink in the associated container 64 through capillarity and retains the same. The ink is formed by dissolving or dispersing dye or pigment in a solvent. In this embodiment, black (BK), cyan (C), light cyan (LC), magenta (M), light magenta (LM), yellow (Y), and light yellow (LY) inks correspond to the different ink cartridges 61.

As described, the ink cartridges 61 are attached to the cartridge holder 41 such that the adjacent ink cartridges 61 are connected to each other through engagement between each projection 62a and the matching recess 62b, as shown in Figs.

8 and 9. In this manner, each ink cartridge 61 is positioned with respect to the adjacent ink cartridge 61.

When attached to the cartridge holder 41, the ink cartridges 61 are positioned in an aligning direction of the ink cartridges 61 (along the axis X of Fig. 3). Further, each ink cartridge 61 is positioned in its forward or rearward direction, or a direction perpendicular to the axes X, Y of Fig. 3 (the axis Z of Fig. 3). Since each ink cartridge 61 is moved along the axis Y when attaching the ink cartridge 61 to the cartridge holder 41, as described, the ink cartridges 61 are accurately installed in the cartridge holder 41. Further, the ink supply ports 69 are precisely positioned with respect to the corresponding ink supply needles 56.

When each ink cartridge 61 is attached to the cartridge holder 41, the corresponding ink supply needle 56 enters the ink supply port 69 to open the valve mechanism 72. The ink in the ink cartridge 61 is thus supplied to the inkjet mechanism 52a through the ink supply port 69 and the ink supply needle 56. Further, the contact group of the circuit board 63 of each ink cartridge 61 contacts the contact group 47a that projects from the rear side of the corresponding connecting member 47. Accordingly, each circuit board 63 is electrically connected to the controller 28 through the corresponding connecting member 47, the IC board 54, and the flexible flat cable 27.

As described, each circuit board 63 is located near to one lateral side of the ink cartridge 61. Thus, as shown in Fig. 9, the circuit boards 63 of the two adjacent ink cartridges 61 are connected to one connecting member 47. However, the connecting member 47 closest to one end of the cartridge holder 41 corresponds to the single circuit board 63

of the ink cartridge 61 closest to the same end.

The first embodiment has the following advantages.

Each ink cartridge 61 has one or two engaging portions 62. The adjacent ink cartridges 61 are thus connected to each other through engagement between the engaging portions 62, or the projections 62a and the matching recesses 62b. Accordingly, each ink cartridge 61 is accurately positioned with respect to the adjacent ink cartridge 61. As a result, when attached to the cartridge holder 41, the ink cartridges 61 are located at correct positions in the cartridge holder 41 as positioned with respect each other.

Each ink cartridge 61 is positioned along a hypothetical plane perpendicular to the direction in which the ink cartridge 61 is moved for attaching the ink cartridge 61 to the cartridge holder 41 (as indicated by the axis Y of Fig. 3). The contact group of the circuit board 63 of each ink cartridge 61 thus reliably contacts the contact group 47a that projects from the rear side of the corresponding connecting member 47. Accordingly, data is reliably transferred between each circuit board 63 and the controller 28 such that the inkjet printer 21 operates accurately.

Further, the ink supply port 69 of each ink cartridge 61 is accurately positioned with respect to the corresponding ink supply needle 56. Thus, when replacing one ink cartridge 61, for example, the ink supply port 69 of the replacing ink cartridge 61 reliably receives the corresponding ink supply needle 56. This makes it easy to replace any ink cartridge 61.

Each engaging portion 62 of the ink cartridges 61 is the

projection 62a or the recess 62b that have simple shapes. The structure for positioning the ink cartridges 61 thus becomes simple.

The projections 62a and the recesses 62b extend in a direction parallel with the direction in which each ink cartridge 61 is moved for attaching the ink cartridge 61 to the cartridge holder 41 (the axis Y of Fig. 3). Thus, when attaching each ink cartridge 61 to the cartridge holder 41, the projections 62a and the recesses 62b do not interfere. This makes it easy to attach or detach the ink cartridges 61 with respect to the cartridge holder 41.

It is unnecessary to provide a structure for positioning each ink cartridge 61 in the carriage 30. This simplifies the configuration of the carriage 30 and minimizes the same. Also, designing of the carriage 30 and that of the ink cartridges 61 become easy.

The circuit boards 63 of the adjacent two ink cartridges 61 are connected to the single connecting member 47. The number of the connecting members 47 is thus less than the number of the ink cartridges 61. This simplifies the configuration of the carriage 30.

(Second Embodiment)

A second embodiment according to the present invention will hereafter be described with reference to Fig. 10. The description focuses on the difference between the second embodiment and the first embodiment illustrated in Figs. 1 to 9. As shown in Fig. 10, in the second embodiment, each projection 62a of the ink cartridges 61 has a different dimension in a direction of the axis Z of Fig. 3, or a

different width. Correspondingly, each recess 62b of the ink cartridges 61 has a different width. In other words, the width of the projection 62a and that of the matching recess 62b of one pair of adjacent ink cartridges 61 are different from the width of the projection 62a and that of the matching recess 62b of another pair of adjacent ink cartridges 41.

The projection 62a and the matching recess 62b of the adjacent ink cartridges 61 form a fitting structure for engaging these ink cartridges 61. The widths of the projections 62a and those of the matching recesses 62b become smaller gradually from the lowermost projection 62a and the matching recess 62b toward the uppermost, as viewed in Fig. 10. That is, the widths of the fitting structures become smaller gradually from the lowermost fitting structure toward the uppermost, as viewed in Fig. 10.

Accordingly, the second embodiment has the following advantages, in addition to those of the first embodiment of Figs. 1 to 9.

When attaching the ink cartridges 61 to the cartridge holder 41, the ink cartridges 61 are connected together as aligned in a predetermined order simply by engaging each projection 62a and the matching recess 62b, which have equal widths. This makes it possible to attach the ink cartridges 61 to the cartridge holder 41 in the correct alignment order easily and accurately.

(Third Embodiment)

A third embodiment according to the present invention will hereafter be described with reference to Fig. 11. The description focuses on the difference between the third

embodiment and the second embodiment illustrated in Fig. 10. As shown in Fig. 11, to the contrary of the second embodiment of Fig. 10, the widths of the projections 62a and those of the matching recesses 62b become greater gradually from the lowermost projection 62a and the matching recess 62b toward the uppermost, as viewed in Fig. 11.

Also, the ink cartridge 61 corresponding to an end of the cartridge holder 41 (the uppermost ink cartridge 61, as viewed in Fig. 11) is larger than the remaining ink cartridges 61. Also, the recess 62b of the relatively large ink cartridge 61 is larger than the recesses 62b of the remaining, relatively small ink cartridges 61. Further, in each of the ink cartridges 61 other than the two ink cartridges 61 corresponding to the opposite ends of the cartridge holder 41, the width of the projection 62a is larger than that of the recess 62b.

Accordingly, the third embodiment has the following advantages, in addition to those of the second embodiment of Fig. 10.

In the second embodiment, in each ink cartridge 61 that has the projection 62a and the recess 62b, the width of the projection 62a is smaller than that of the recess 62b. Thus, the dimension of this ink cartridge 61 in a direction of the axis X of Fig. 3, or the thickness of the ink cartridge 61, becomes relatively small at a position corresponding to a portion of the recess 62b that does not correspond to the projection 62a. In other words, the thickness of each ink cartridge 61 of the second embodiment is partially reduced. In contrast, in the third embodiment, each ink cartridge 61 has a substantially uniform thickness. Accordingly, any section of the porous body 65 is not excessively compressed,

thus ink optimally flows in each ink cartridge 61. This reduces the amount of the ink that remains unconsumed in the ink cartridge 61.

(Fourth Embodiment)

A fourth embodiment according to the present invention will hereafter be described with reference to Fig. 12. The description focuses on the difference between the fourth embodiment and the third embodiment illustrated in Fig. 11. As shown in Fig. 12, in the fourth embodiment, each ink cartridge 61 has a main body 67 and a sub body 68 connected to the main body 67. Each sub body 68 has the projection 62a and the recess 62b. Each sub body 68 is hollow and forms an ink chamber together with the associated main body 67. Alternatively, the sub bodies 68 may be solid.

The fourth embodiment has the following advantages, in addition to those of the third embodiment of Fig. 11.

Since the main bodies 67 are identical, the main bodies 67 are fabricated efficiently.

(Fifth Embodiment)

Fig. 13 shows a fifth embodiment in which a plurality of (two, in the drawing) engaging portions 62 (the projections 62a or the recesses 62b) are formed at each side of each ink cartridge 61. Each engaging portion 62 has a semicircular cross-sectional shape and extends in a direction parallel with the direction in which each ink cartridge 61 is moved for attaching the ink cartridge 61 to the cartridge holder 41.

The illustrated embodiments may be modified as follows.

The numbers, the shapes, and the locations of the engaging portions 62 (the projections 62a and the recesses 62b) are not restricted to those of the illustrated embodiments but may be modified as necessary. For example, each engaging portion 62 may have a conical or pillar-like shape.

The structures for aligning the ink cartridges 61 in a predetermined order are not restricted to those of the illustrated embodiments. The structures may have any form as long as, for example, one matching set of the projection(s) 62a and the recess(es) 62b and another matching set are different in at least number or shape or location. In other words, the fitting structure between the opposed contact sides of one pair of adjacent ink cartridges 61 and that of another pair must be different in form.

The ink cartridges 41 do not necessarily have to be installed in the carriage 30 but may be installed in the body of the inkjet printer 21. This structure also has the same advantages as those of the illustrated embodiments.

The connecting members 47 may be formed as a single connecting member. If this is the case, the cartridge holder 41 and the base 53 of the printing head 51 each have to include a single window for receiving the connecting member. This simplifies the structure of the carriage 30.

The present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.